	Title	Current OR
1	Circuit-substrate w rking system and electronic-circuit fabricating pr cess	438/14
2	El ctric-component mounting system wherein electric component is positioned with thermal expansion of the system taken into account	318/600 ✓
3	Electric-component mounting system and method of detecting positioning error in the system	29/833
4	Method of detecting position of rotation axis of suction nozzle, and electric-component mounting system	29/834
5	Variable-width substrate conveyor, method of changing width of the same, and method of matching widths of two adjacent substrate conveyors	198/817
6	Method and apparatus of detecting positioning error of electric component held by suction nozzle, and method of mounting the electric component	29/833
7	Suction nozzle, method of detecting hold position of electric component, methods of detecting bending and angular position of suction pipe, and electric-component handling device	382/291
8	Method of supplying electric component, and electric-component mounting system	29/832
9	Jig for use in measuring mounting accuracy of mounting device and method of measuring mounting accuracy of mounting device	29/833
10	Electric component mounting system has controller that determines drive signal to b appli d t drive device bas d on image f electronic c mp nent taken by image-taking device p sitioned r lativ to lectr nic c mp nent	

	Current XRef
1	
2	361/135
3	29/739; 29/740; 29/834
4	29/740; 29/743; 29/832; 29/833
5	
6	29/701; 29/739; 29/834
7	
8	29/740; 29/743; 29/834
9	33/645; 382/151; 438/16
10	

	Title	Current OR
1	Circuit-substrate w rking syst m and electronic-circuit fabricating process	438/14
2	Electric-c mponent m unting system wherein electric component is positioned with thermal expansion of the system taken into account	318/600
3	Electric-component mounting method and system	29/832
4	Electric-component mounting system and method of detecting positioning error in the system	29/833
5	Electric-component mounting system	361/728
6	Printed-board supporting device, electric-component mounting system, and process of manufacturing printed-circuit board	361/752
7	Electric-component mounting system	29/740
8	Electric-component mounting system and method	29/739
9	Variable-width substrate conveyor, method of changing width of the same, and method of matching widths of two adjacent substrate conveyors	198/817
10	Method of supplying electric component, and electric-component mounting system	29/832
11	Apparatus for positioning electronic component holder head and apparatus for transferring electronic component	198/468.4
12	Electric-component supplying method and apparatus	226/110

	Current XRef
1	
2	361/135
3	29/740; 29/743; 29/834
4	29/739; 29/740; 29/834
5	
6	
7	29/743
8	29/593; 29/743; 29/833
9	
10	29/740; 29/743; 29/834
11	198/468.2; 198/476.1; 198/477.1; 198/803.5
12	156/566; 226/128; 226/148; 414/416.01

	Titl	Current OR
13	Apparatus f r p siti ning electr nic comp n nt hold r h ad and apparatus f r transferring electr nic comp nent	198/468.4
14	Electronic component transferring apparatus	29/740
15	Electric component transferring apparatus having function of testing negative-pressure suction, and apparatus and method for testing negative-pressure suction	73/37
16	Electronic component transferring device and method, and electronic component mounting system and method	29/832

	Current XRef
13	198/468.2; 198/476.1; 198/477.1; 198/803.5
14	198/470.1; 198/471.1; 198/574; 198/586; 29/743; 29/DIG.44; 414/752.1
15	29/743; 29/834; 294/64.1; 414/225.01; 414/752.1; 73/37.6; 901/40
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ABSTRACT:

A method of detecting a relative positioning error between a fiducial-mark imaging device and a substrate-holding device in an electric-component mounting system wherein the fiducial-mark imaging device is arranged to take an image of at least one substrate fiducial mark provided on a circuit substrate, and a positioning error of the circuit substrate as held by the substrate-holding device is detected on the basis of the image of the at least one substrate fiducial mark, so that an electric component is mounted by

a mounting head onto the circuit substrate, so as to eliminate the positioning error of the circuit substrate, wherein the fiducial-mark imaging device is operated to take an image of at least one holding-device fiducial mark provided on the substrate-holding device, and the relative positioning error between the fiducial-mark imaging device and the substrate-holding device is detected on the basis of a positioning error of the image of the holding-device fiducial mark within an imaging area of the at least one fiducial-mark imaging device.

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Current US Classification, US Secondary Class/Subclass - CCSR (2):

29/740

Summary of Invention Paragraph - BSTX (9):

[0008] However, the conventionally practiced manual pre-positioning using the measuring jig is cumbersome and time-consuming, inevitably delaying starting of a production run of the electric-component mounting system, of the manual pre-positioning is effected immediately before the mounting of the electric components. Further, it is difficult to perform the manual pre-positioning during the production run of the system, so that the movement data for the substrate-positioning device cannot be compensated for the positioning error of the circuit substrate or the component-mountings spots which may arise from **thermal expansion** of various parts of the system in operation, and which may deteriorate the positioning accuracy of the electric components as mounted on the circuit substrate.

Summary of Invention Paragraph - BSTX (23):

[0021] After the initiation of the production run of the system to mount the electric components on the circuit substrate, the temperatures of the component members of the system rise due to frictional movements of movable members and operations of drive sources of the system, so that positioning errors of the component members due to their **thermal expansion** may arise, causing a risk of variation in the amount of relative positioning error between the fiducial-mark imaging device and the substrate-holding device. In view of this tendency, the detection of the relative positioning error between those two devices is desirably effected during an interruption of the continuous run of the system, to update the amount of the relative positioning error. Accordingly, the accuracy of mounting of the electric components on the circuit substrate can be significantly improved, by adjusting the movement data for positioning the substrate-holding device relative to the mounting head, so as to eliminate the updated relative positioning error between the fiducial-mark imaging device and the substrate-holding device.

Detail Description Paragraph - DETX (98):

[0241] When the electronic-component mounting system 12 has been operated to perform the component mounting operation for the predetermined time, various component members such as the ballscrews 70, 78 of the XY table 64 of the system 12 have **thermal expansion** due to a rise of the operating temperature of the various devices. Accordingly, the distances of movement of the X-axis slide 74 and the Y-axis slide 82 of the XY table 64 according to certain movement data vary depending upon the amount of the **thermal expansion,** or

depending upon whether the ballscrews 70, 78 have **thermal expansion** or not.
Further, the positions of the stationary members may vary due to their **thermal expansion**. For example, the position of the fiducial-mark camera 106 relative to the holder member 107, and the positions of the component cameras 350, 352 relative to the frame 10 may vary due to the **thermal expansion** of the system 12. Accordingly, the positions of the images of the holding-device fiducial marks 370 in the imaging area of the fiducial-mark camera 106 may vary. In view of such variations, the positioning error of the fiducial-mark camera 106 relative to the reference nozzle axis and the actual zero point of the XY table 64 must be updated in the presence of the **thermal expansion**, on the basis of the images of the fiducial marks 370 and the sucking surface 201 of the reference suction nozzle 190 taken by the fiducial-mark camera 106. When the images of the fiducial marks 370 are taken, the PWB holding device 18 is moved to the zero point presently established for the XY table 64. Further, the positioning errors of the centers of imaging areas of the component cameras 350, 352 relative to the reference nozzle axis are also updated.

Detail Description Paragraph - DETX (99):
[0242] After the relative positioning errors, etc. have been obtained, the light guiding device 366 is removed from the mounting block 362, and the component mounting operation of the system 12 is resumed. In this component mounting operation, the printed-wiring boards 60 are moved according to the actual zero point newly established for the XY table 64, and the newly obtained relative positioning errors. While the positioning error of each component-mounting spot on the board 60 which is obtained

on the basis of the
images of the board fiducial marks 104 is influenced by the **thermal expansion**
of the ballscrews 70, 78 of the XY table 64, the use of the obtained
positioning error of each component-mounting spot to adjust the movement data
for mounting the electronic component 38 at the component-mounting spot does
not cause a problem, since the movements of the board 60 to mount the
electronic components 38 at the respective component-mounting spots are
influenced by the **thermal expansion** in the same manner as the movement of the
board 60 when the images of the board fiducial marks 104 are taken by the
fiducial-mark camera 106.

Detail Description Paragraph - DETX (100):

[0243] It is also noted that the temperature of the printed-wiring board 60
newly loaded onto the PWB holding device 16 is not so high. Further, the board
60 is not influenced by the temperature of the PWB holding device 18 having the
thermal expansion, since the board 60 is merely supported in abutting
point-contact with the support pins 94 and is clamped only at its widthwise end
portions by and between the support surfaces 103 and the clamping members 105.
Accordingly, the electronic components 38 can be mounted on the respective
component-mounting spots on the board 60 with high accuracy, by moving the
board 60 relative to the newly established zero point, according to the
predetermined movement data sets as adjusted so as to eliminate the newly
obtained relative positioning errors